WHAT IS CLAIMED IS:

1. A drill tool, comprising:

a bit body;

at least one bearing shaft extending from the bit body;

a cone mounted for rotation on the bearing shaft;

a first groove formed in a non-loading zone of an outer bearing surface of the bearing shaft; and

a second groove formed in the non-loading zone of the same outer bearing surface of the bearing shaft;

wherein the first groove is circumferentially offset from the second groove.

2. The drill tool of claim 1, wherein the bearing shaft further includes an internal lubrication channel, and further including a first opening within the first groove, the first opening providing for fluid communication between the first groove and the internal lubrication channel.

3. The drill tool of claim 2, wherein the first opening has diameter D satisfying the following equation: $D \approx k*((4/\pi)*(C*L))^{.5}$; wherein: k is a constant greater than one; C=diametrical clearance of the bearing; and L=arc length of the first groove.

4. The drill tool of claim 2, wherein the first opening has diameter D2 satisfying the following equation: $D2 \leq k*((D1 + C)^2 - D1^2)^{0.5}$; wherein: k is a constant less than one; D1=outer surface diameter of the shaft; and C=diametrical clearance of the bearing.

5. The drill tool of claim 2, wherein the first opening has a cross sectional area that is less than 150% of an annular flow area along the outer bearing surface of the bearing shaft in a vicinity of the first groove.

6. The drill tool of claim 2, further comprising a second opening within the second groove, the second opening providing for fluid communication between the second groove and the internal lubrication channel.

7. The drill tool of claim 1, wherein the circumferential offset of the first groove from the second groove defines an attenuation zone extending circumferentially along the outer bearing surface of the bearing shaft between the first groove and second groove.

8. The drill tool of claim 7, wherein the attenuation zone between the first groove and second groove provides a circumferential attenuation that is approximately equal to an axial attenuation provided between either the first groove or the second groove and a further end of the outer bearing surface of the bearing shaft.

9. The drill tool of claim 1, wherein the outer bearing surface of the bearing shaft is an outer cylindrical surface.

10. The drill tool of claim 9, wherein the outer cylindrical surface is a main journal bearing surface.

11. The drill tool of claim 1, wherein the bearing shaft supports a frictional journal bearing.

12. The drill tool of claim 1, wherein the outer bearing surface of the bearing shaft is axially defined between a first edge and a second edge, and wherein the first groove is axially offset and positioned closer to the first edge of the outer bearing surface.

13. The drill tool of claim 12, wherein the axially offset first groove defines a first attenuation zone along the outer bearing surface of the bearing shaft extending axially between the first edge and the first groove and further defines a second attenuation zone along the outer bearing surface of the bearing shaft extending axially between the second groove and the second edge.

14. The drill tool of claim 13, wherein a ratio of a first axial width of the first attenuation zone to a second axial width of the second attenuation zone is between about 3-to-1 and about 6-to-1.

15. The drill tool of claim 12, wherein the second groove is axially offset and positioned closer to the second edge of the outer bearing surface.

16. The drill tool of claim 1, wherein each of the first and second grooves has an axial width, and wherein the axial width of each of the first and second grooves is no more than 70% of an axial width of the outer bearing surface of the bearing shaft between the first and second edges.

17. The drill tool of claim 1, each of the first and second grooves has an axial width and a circumferential length, and wherein a ratio of circumferential length to axial width of each of the first and second grooves is between about 2-to-1 and about 4-to-1.

18. The drill tool of claim 1, wherein the outer bearing surface of the bearing shaft is a cylindrical surface axially positioned between a source of a cone pumping pressure pulse and a sealing system for the cone and bearing shaft, and wherein the first and second grooves are positioned in the non-loading zone of the outer bearing surface so as to each define a first attenuation zone and a second attenuation zone, wherein the first and second attenuation zones axially restrict propagation of the cone pumping pressure pulse towards the sealing system.

19. The drill tool of claim 18, wherein the first attenuation zone has a first axial width extending between a first edge of the groove and a first edge of the outer bearing surface, and wherein the second attenuation zone has a second axial width extending between a second edge of the groove and a second edge of the outer bearing surface.

20. The drill tool of claim 19, wherein the first axial width is different than the second axial width.

21. The drill tool of claim 20, wherein a ratio of the first axial width to the second axial width is between about 3-to-1 and about 6-to-1.

22. The drill tool of claim 18, wherein the circumferential offset of the first groove from the second groove defines a third attenuation zone extending circumferentially along the outer bearing surface of the bearing shaft between the first groove and second groove, wherein the first, second and third attenuation zones axially restrict propagation of the cone pumping pressure pulse towards the sealing system.

23. The drill tool of claim 22, wherein the third attenuation zone provides a circumferential attenuation of the cone pumping pressure pulse that is approximately equal to an axial attenuation of the cone pumping pressure pulse provided between either the first groove or the second groove and a further end of the outer bearing surface of the bearing shaft.

24. The drill tool of claim 18, wherein the first and second grooves are axially offset from each other.

25. The drill tool of claim 18, wherein the bearing shaft further includes an internal lubrication channel, and further including a first opening within the first groove, the first opening providing for fluid communication between the first groove and the internal lubrication channel and propagation of the cone pumping pressure pulse.

CLAIMS

What is claimed is:

1. A drill tool, comprising:

a bit body;

at least one bearing shaft extending from the bit body;

a cone mounted for rotation on the bearing shaft;

a first groove formed in a non-loading zone of an outer bearing surface of the bearing shaft; and

a second groove formed in the non-loading zone of the same outer bearing surface of the bearing shaft;

wherein the first groove is circumferentially separated from the second groove by a portion of the outer bearing surface, and

wherein said first and second grooves are positioned on the outer bearing surface in an axially non-symmetric manner.

2. The drill tool of claim 1, wherein the bearing shaft further includes an internal lubrication channel, and further including a first opening within the first groove, the first opening providing for fluid communication between the first groove and the internal lubrication channel.

3. The drill tool of claim 2, wherein the first opening has diameter D satisfying the following equation: $D \approx k*((4/\pi)*(C*L))^{0.5}$; wherein: k is a constant greater than one; C=diametrical clearance of the bearing; and L=arc length of the first groove.

4. The drill tool of claim 2, wherein the first opening has diameter D2 satisfying the following equation: $D2 \leq k*((D1 + C)^2 - D1^2)^{0.5}$; wherein: k is a constant less than one; D1=outer surface diameter of the shaft; and C=diametrical clearance of the

bearing.

5. The drill tool of claim 2, wherein the first opening has a cross sectional area that is less than 150% of an annular flow area along the outer bearing surface of the bearing shaft in a vicinity of the first groove.

6. The drill tool of claim 2, further comprising a second opening within the second groove, the second opening providing for fluid communication between the second groove and the internal lubrication channel.

7. The drill tool of claim 1, wherein the circumferential separation of the first groove from the second groove defines an attenuation zone extending circumferentially along said portion of the outer bearing surface of the bearing shaft between the first groove and second groove.

8. The drill tool of claim 7, wherein the attenuation zone between the first groove and second groove provides a circumferential attenuation length that is approximately equal to an axial attenuation length provided between either the first groove or the second groove and a further end of the outer bearing surface of the bearing shaft.

9. The drill tool of claim 1, wherein the outer bearing surface of the bearing shaft is an outer cylindrical surface.

10. The drill tool of claim 9, wherein the outer cylindrical surface is a main journal bearing surface.

11. The drill tool of claim 1, wherein the bearing shaft supports a frictional journal bearing.

12. The drill tool of claim 1, wherein the outer bearing surface of the bearing shaft is axially defined between a first edge and a second edge, and wherein said axially non-symmetric positioning of the first and second grooves positions the first groove closer to

the first edge of the outer bearing surface than the second groove and positions the second groove closer to the second edge of the outer bearing surface than the first groove.

13. The drill tool of claim 12, wherein said axially non-symmetric positioning of the first and second grooves defines a first axial attenuation zone along the outer bearing surface of the bearing shaft with a first length extending between the first edge and the first groove and further defines a second axial attenuation zone along the outer bearing surface of the bearing shaft with a second length extending between the second groove and the second edge.

14. The drill tool of claim 12, wherein each of the first and second grooves has an axial dimension, and wherein the axial dimension of each of the first and second grooves is no more than 70% of an axial dimension of the outer bearing surface of the bearing shaft between the first and second edges.

15. The drill tool of claim 1, each of the first and second grooves has an axial dimension and a circumferential dimension, and wherein a ratio of circumferential dimension to axial dimension of each of the first and second grooves is between about 2-to-1 and about 4-to-1.

16. The drill tool of claim 1, wherein axially non-symmetric first and second grooves have a circumferential axial overlap.

17. A drill tool, comprising:

a bit body;

at least one bearing shaft extending from the bit body;

a cone mounted for rotation on the bearing shaft;

a first groove formed in a non-loading zone of an outer bearing surface of the bearing shaft; and

a second groove formed in the non-loading zone of the same outer bearing surface of the bearing shaft;

wherein the first groove is circumferentially offset from the second groove,

wherein the outer bearing surface of the bearing shaft is a cylindrical surface axially positioned between a source of a cone pumping pressure pulse and a sealing system for the cone and bearing shaft, and

wherein the first and second grooves are positioned in the non-loading zone of the outer bearing surface so as to each define a first attenuation zone and a second attenuation zone, wherein the first and second attenuation zones axially restrict propagation of the cone pumping pressure pulse towards the sealing system.

18. The drill tool of claim 17, wherein the first attenuation zone has a first axial dimension extending between a first edge of the groove and a first edge of the outer bearing surface, and wherein the second attenuation zone has a second axial dimension extending between a second edge of the groove and a second edge of the outer bearing surface.

19. The drill tool of claim 18, wherein the first axial dimension is different than the second axial dimension.

20. The drill tool of claim 19, wherein a ratio of the first axial dimension to the second axial dimension is between about 3-to-1 and about 6-to-1.

21. The drill tool of claim 17, wherein the circumferential offset of the first groove from the second groove defines a third attenuation zone extending circumferentially along the outer bearing surface of the bearing shaft between the first groove and second groove, wherein the first, second and third attenuation zones axially restrict propagation of the cone pumping pressure pulse towards the sealing system.

22. The drill tool of claim 21, wherein the third attenuation zone provides a circumferential attenuation of the cone pumping pressure pulse that is approximately equal to an axial attenuation of the cone pumping pressure pulse provided between either the first groove or the second groove and a further end of the outer bearing surface of the bearing shaft.

23. The drill tool of claim 17, wherein the first and second grooves are axially offset from each other.

24. The drill tool of claim 17, wherein the bearing shaft further includes an internal lubrication channel, and further including a first opening within the first groove, the first opening providing for fluid communication between the first groove and the internal lubrication channel and propagation of the cone pumping pressure pulse.

25. The drill tool of claim 17, wherein the sealing system comprises an annular seal gland and a seal member retained within the annular seal gland.

26. The drill tool of claim 25, wherein the seal member is an o-ring seal.

27. A drill tool, comprising:

a bit body;

at least one bearing shaft extending from the bit body;

a cone mounted for rotation on the bearing shaft;

a first groove formed in a non-loading zone of an outer bearing surface of the bearing shaft; and

a second groove formed in the non-loading zone of the same outer bearing surface of the bearing shaft;

wherein the first groove is circumferentially separated from the second groove by a portion of the outer bearing surface, and

wherein a center of the first groove is axially offset from a center of the second groove.